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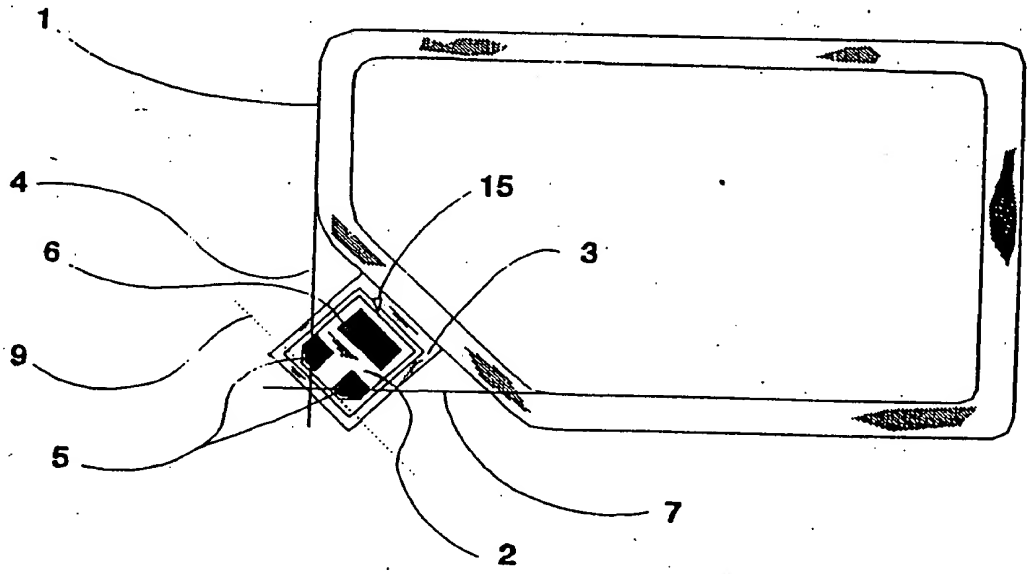
(54) Title: METHOD FOR CONNECTING A MICROCIRCUIT TO THE INDUCTIVE COUPLING COIL OF A SMART CARD AND ASSEMBLY FOR AN INDUCTIVELY COUPLED SMART CARD



(57) Abstract

The invention concerns a method for connecting a microcircuit (2) to the inductive coupling coil (1, 11) of a smart card and an assembly in an inductively coupled smart card. In accordance with the method according to the invention, during the manufacturing phase of said coil (1), the coil is complemented with a socket (3) incorporating an open recess/slot arrangement (15, 13) to which socket the conductor ends (4, 7) of the coil (1, 11) are attached so as to make them pass over the open recess/slot arrangement (13, 15) of the socket, and the microcircuit (2) is bonded by its contact areas (5) to the sections of the coil conductors (4, 7) passing over the open recess/slot arrangement (13, 15).

Method for connecting a microcircuit to the inductive coupling coil of a smart card and assembly for an inductively coupled smart card

The present invention is related to a method according to the preamble of claim 1 for connecting a microcircuit to the inductive coupling coil of a smart card.

The invention also concerns an assembly for an inductively coupled smart card.

Inductively coupled smart cards are employed for instance as pay tokens in bus traffic, whereby a card of the same size as a credit card can be loaded with the value of prepaid tokens that can be paid off at card reader terminals of busses. The card communicates with the external world via a coupling coil connected to a microcircuit provided with memory, thus requiring no mechanical contact between the card and the card reader as is necessary with the use of conventional magnetic stripe cards. To maximize the coupling sensitivity, the coil is advantageously designed for maximum possible diameter, and in practice the coil is conformant with the outer rim of the card.

Such coils are fabricated through automated production methods, and coils of desired design are commercially available with a desired number of turns from customer-specified conductor material. The coils are delivered with unterminated conductor ends.

WO publication 91/16718 discloses a method for connecting a coil of the above-described kind to a printed-circuit board, which has a microcircuit comprised of memory and control circuits bonded to it. The embodiment according to the publication necessitates multiple time-consuming work phases: printed-circuit manufacturing, placement of the microcircuit onto the printed-circuit board, forming of bonding areas for the microcircuit onto the printed-circuit board, and finally connecting the printed-circuit board with the coil. Although all these work phases can be automated as such, the great number of required operations causes a long product throughput time in the manufacturing process.

It is an object of the present invention to overcome the above-described disadvantages of prior-art technology and to achieve an entirely novel method for connecting a microcircuit with the inductive coupling coil of a smart card.

The invention is based on the concept of providing the coil already at its manufacturing phase with a mounting socket for the microcircuit and then attaching the conductor ends of the coil to predetermined positions in the socket. Furthermore, the socket incorporates a mounting recess for the microcircuit permitting direct connection of the microcircuit from its contact areas to the coil conductor ends which are located at predetermined positions in the socket.

More specifically, the method according to the invention is characterized by what is stated in the characterizing part of claim 1.

Furthermore, the assembly according to the invention is characterized by what is stated in the characterizing part of claim 2.

The invention provides significant benefits.

The attachment of the socket to the coil is integrated into the manufacturing process of the coil, and by virtue of the socket, the mounting of the microcircuit is simplified, whereby several work phases are obviated in respect to conventional techniques. The reduction of work phases attains undeniable benefits in shortened work throughput time, and quality control is improved, since the number of work phases to be verified is reduced. As the product related to the invention, namely the smart card, will be a mass-produced, low-priced commodity comparable to credit and bank cards, any production rate improvements associated with the manufacturing techniques of such a product will have a most significant economical value.

In the following the invention is examined in greater detail with reference to exemplifying embodiments illustrated in the annexed drawing in which

Figure 1 shows an inductively coupled smart card embodiment according to the invention in a top view.

Figure 2 shows another inductively coupled smart card embodiment according to the invention in a top view.

With reference to Fig. 1, the shape of the coil 1 is essentially conformant to the outside dimensions of a smart card. However, to accommodate the mounting of a microcircuit 2, the left lower corner of the coil 1 is in this embodiment wound in a slanted manner closer to the center of the coil 1. The indented area left free in this manner is provided with, e.g., a plastic socket 3 which is appropriately coated with similar thermosetting adhesive as is also applied onto the conductor of the coil. At the start of the manufacturing stage of the coil 1, the first end 7 of the coil conductor is attached to the socket 3, and the winding of the coil is then continued until the other end 4 of the conductor of the coil 1 can be attached to the socket 3. As both the conductor of the coil 1 and the socket 3 are coated with a compatible thermosetting adhesive, these elements will firmly adhere to each other during a heating phase. The heating phase is implemented by applying external heat onto the coil, or alternatively, applying a current pulse on the coil 1, or using a combination of these two operations. Consequently, the end result of the winding operation is a semifabricated product comprising the coil 1 and, attached thereto, a socket 3 with the ends of the conductor of the coil 1 connected to said socket. The socket 3 is designed so as to permit the routing of the coil conductor ends 4 and 7 crosswise over an unoccupied space 15, whereby the microcircuit 2 can be readily mounted in said socket 3 so that contact areas 5 of the microcircuit 2 are directly aligned over said coil conductor ends 4 and 5 in this unoccupied space 15. In the embodiment illustrated in the diagram of the figure, this concept is implemented by providing the socket 3 with an open recess 15 over which the conductors 4 and 7 are routed crosswise. According to the invention the open recess 15 is designed to perform the alignment of the microcircuit 2 in place so that the contact areas 5 of the microcircuit 2 will be located at the conductor ends 4 and

7. To ensure accurate alignment, the dimensions of the open recess 15 must be essentially conformant to the outer dimensions of the microcircuit 2. The conductor ends 4 and 7 are bonded to the contact areas 5 by soldering or welding. After the bonding phase, excess material from the socket 3 and the conductor ends 4 and 7 are trimmed away along the marked line 9.

Next to the bonding phase, the coil 1 and the microcircuit 2 are protected with a suitable encapsulation structure by, e.g., laminating the structure from both sides with a suitable plastic material. The encapsulating structure can also be formed by casting the coil 1 and the microcircuit 2 into a polymer resin.

With reference to Fig. 2, the coil 11 in this embodiment is essentially conformant to the outer shape of the smart card, while the socket 10 is U-shaped. The bonding of the coil conductors 4 and 7 is assured in this embodiment by routing the conductor ends crosswise over the U-shaped slot, thereby permitting direct alignment of the microcircuit 2, and in particular, its contact areas 5 under the conductor ends 4 and 7. For secure mounting, the U-shaped slot 13 has a width equal to that of the microcircuit 2. Correct insertion of the microcircuit into the U-shaped slot 13 is assured by firmly pushing the microcircuit 2 fully home to the bottom of the slot. Gravity assisted placement is also possible by tilting the combination coil 11/socket 10 so as to permit dropping the microcircuit in place. Removal of excess material is performed in the same manner along the marked line 9 as illustrated in the diagram of Fig. 1.

The microcircuit 2 is inserted into the socket 3 or 10 from, e.g., a carrier film, or alternatively, using a robot with machine vision.

A further characterizing requirement in the implementation of the invention is that at least one external dimension of the recess or slot arrangement 15, 13 is designed to be essentially conformant with an outer dimension of the microcircuit 2.

Claims

1. A method for connecting a microcircuit (2) to the inductive coupling coil (1, 11) of a smart card, characterized in that

- during the manufacturing phase of said coil (1), the coil is complemented with a socket (3) having an open recess/slot arrangement (15, 13),

- the conductor ends (4, 7) of the coil (1, 11) are attached to said socket so as to make them pass over said open recess/slot arrangement (13, 15), and

- said microcircuit (2) is bonded by its contact areas (5) to said sections of the coil conductors (4, 7) passing over said open recess/slot arrangement (13, 15).

2. An assembly for an inductively coupled smart card, said card comprising

- a coil (1, 11) and

- a microcircuit (2) suited for bonding to said coil (1, 11),

characterized in that

- said coil (1, 11) is provided with a socket (3, 10) having an open recess/slot arrangement (13, 15),

- the conductor ends (4, 7) of the coil (1, 11) are attached to said socket (3, 10) so as to make them pass over said open recess/slot arrangement (13, 15), and

– at least one dimension of said open recess/slot arrangement (13, 15) is conformant with one dimension of said microcircuit (2) to permit insertion of said circuit into said open recess/slot arrangement (13, 15).

3. An assembly as defined in claim 2, c h a r a c t e r i z e d in that said socket (3) is provided with an open recess (15) essentially conformant to the outer dimensions of said microcircuit (2).

4. An assembly as defined in claim 2, c h a r a c t e r i z e d in that said socket (10) is provided with a U-shaped slot (13) essentially conformant to the width of said microcircuit (2).

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 93/00138

A. CLASSIFICATION OF SUBJECT MATTER

IPC5: G06K 19/07
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: G06K, G07F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US, A, 4999742 (J-M. STAMPFLI), 12 March 1991 (12.03.91), abstract --	1-4
X	WO, A1, 9116718 (A. GUSTAFSON), 31 October 1991 (31.10.91), abstract --	1-4
X	US, A, 4960983 (T. INOUE), 2 October 1990 (02.10.90), abstract --	1-4
X	WO, A1, 8702806 (D. ARTACHO), 7 May 1987 (07.05.87), figure 3, abstract --	1-4

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 July 1993	09 -07- 1993
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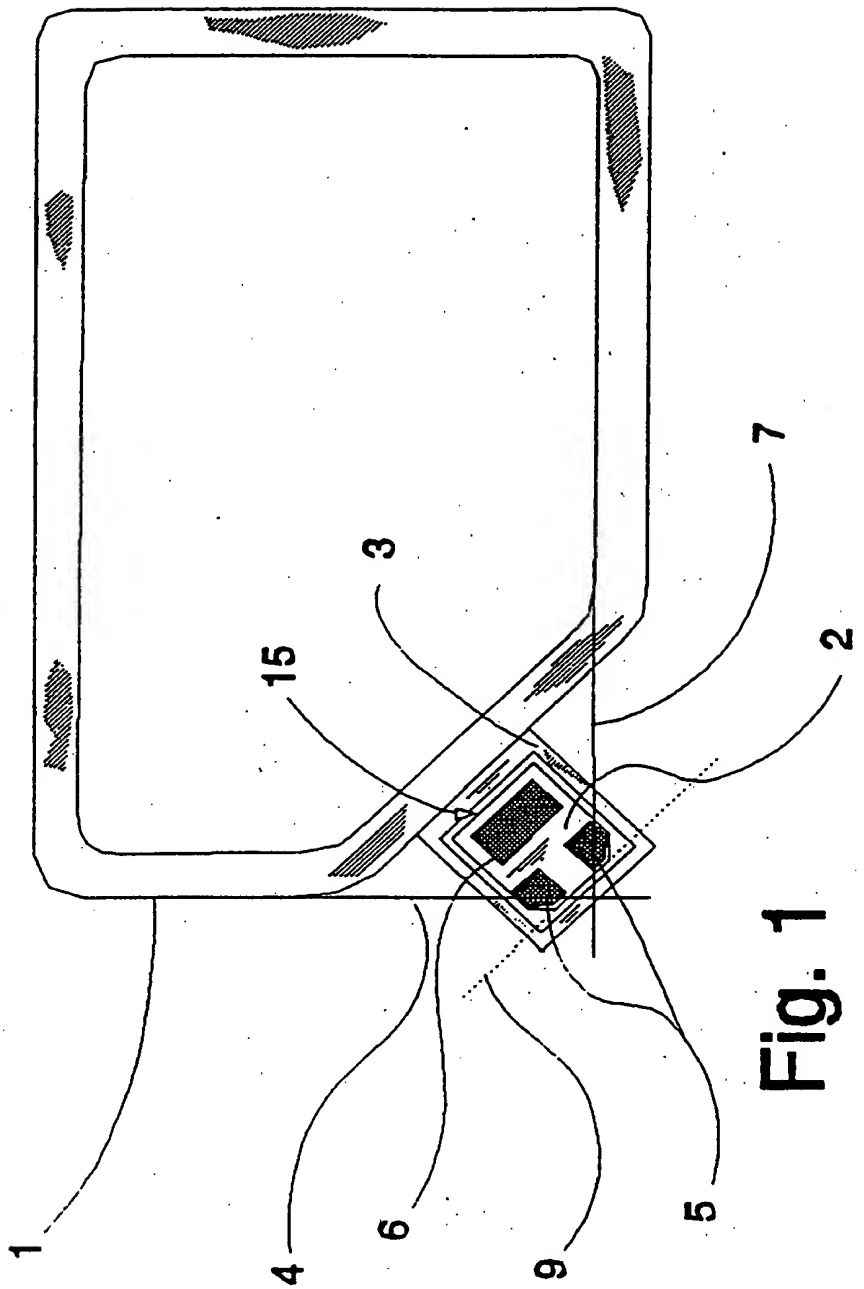

Fig. 1

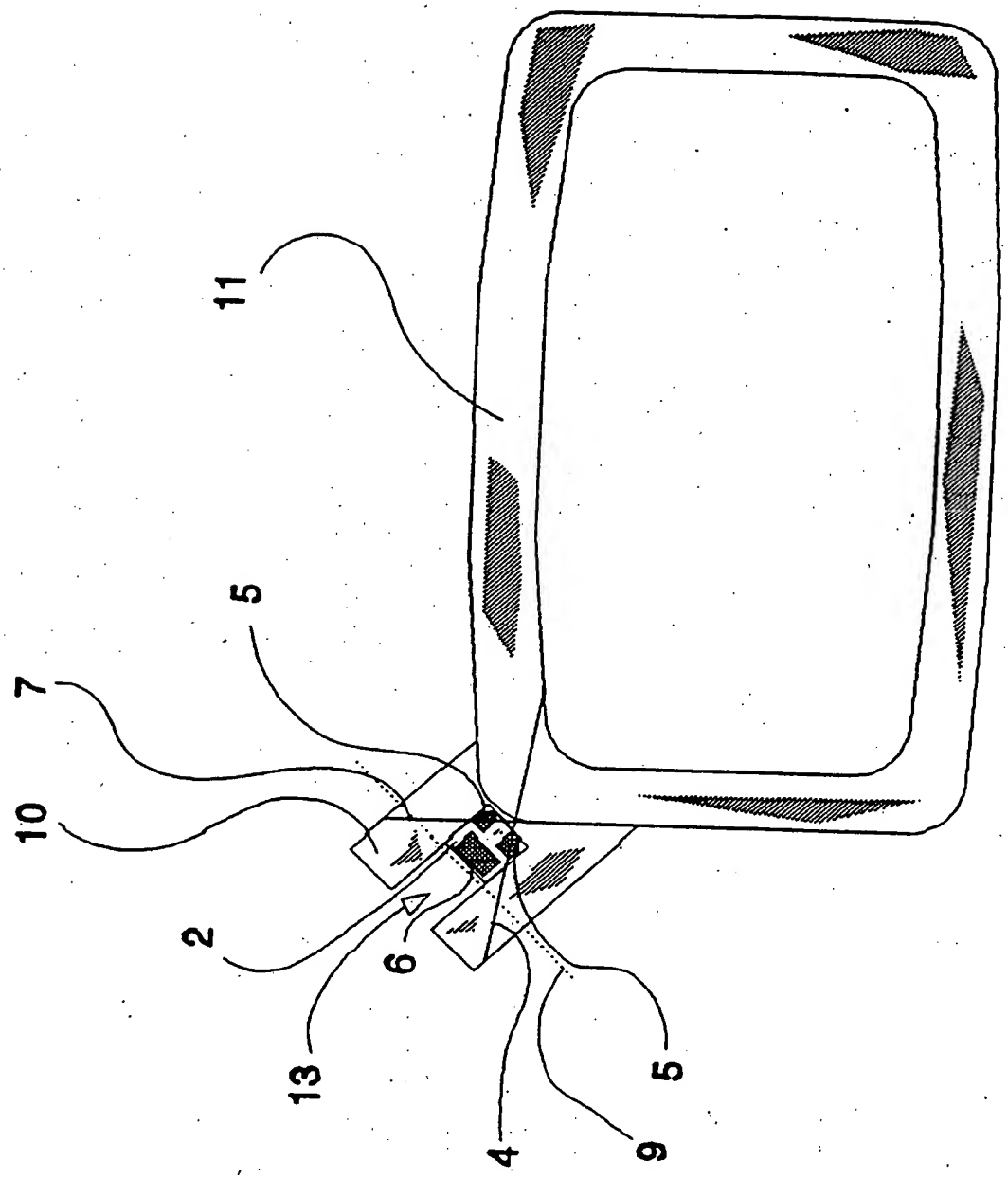

Fig. 2